IMAAC
Interagency Modeling and Atmospheric Assessment Center

Real World

Benzene Release at Petrochemical Depot Deer Park, TX – Worst Case

26MAR2019 1020Z

RFI – 19 – 0254sU

26MAR2019

Requestor: NWS – Houston WFO

Request Summary

Deer Park, Texas Latitude: 29.732437° N Longitude: 95.091517° W
Time: 0400 CDT Date: 26MAR2019
Hazard: • Benzene vapor released at 60 kg/min
Weather: • High Resolution Numerical Weather Prediction: 12 km NAM from NCEP (CONUS) • Initialized: 06Z 26MAR2019

- ## Request Data
  - Requestor: Brian Kyle, Lead Forecast Meteorologist, National Weather Service – Houston WFO
  - Contact: 1-800-846-1828, sr-hgx.ops@noaa.gov
  - Request: Downwind hazard for a benzene release in Deer Park, TX as a consequence of the petrochemical fire earlier this week.

- ## Solution
  - Summary: AEGLs at 8 hours, surface dosage at 36 hours, concentrations at multiple times, and recent readings are provided.
  - Employment: Real World
  - Reachback: R. Lucheta

Modeling Summary

- Known Information: An unknown source at the site of the Deer Park fire is releasing benzene. Current rate and location are unknown. There is no fire currently burning.
- Readings on 25 Mar indicated benzene concentrations near the tanks close of approx. 20 ppm. Most nearby air monitoring sensors in the surrounding area are only measuring less than 0.499 ppm.
- Reachback modeled a continuous release of benzene vapor at a rate of 60 kg/min. This produced results that seemed roughly consistent with the 25 Mar readings at the tank farm while still providing a margin of safety.
- **Benzene is mildly toxic – serious effects require exposures to hundreds or thousands of ppm for sustained periods of time**.

Modeling Caveats

- The rate of benzene release should have some degree of time variance as local temperatures change, but this was not accounted for in the model.

- There may be some thermal lofting of the benzene occurring, but that could not be determined definitively.

- Matching data to model plume calculations is inherently difficult due to the meander and intermittency of real world plume transport and dispersion. These small-scale effects produce a randomness that can be captured in the model but not predicted a priori. **This small-scale variability can cause sensors in very close proximity to produce wildly different results**.

Benzene Conc. @ Ground Level; 0600 CDT 26-MAR (Far View)
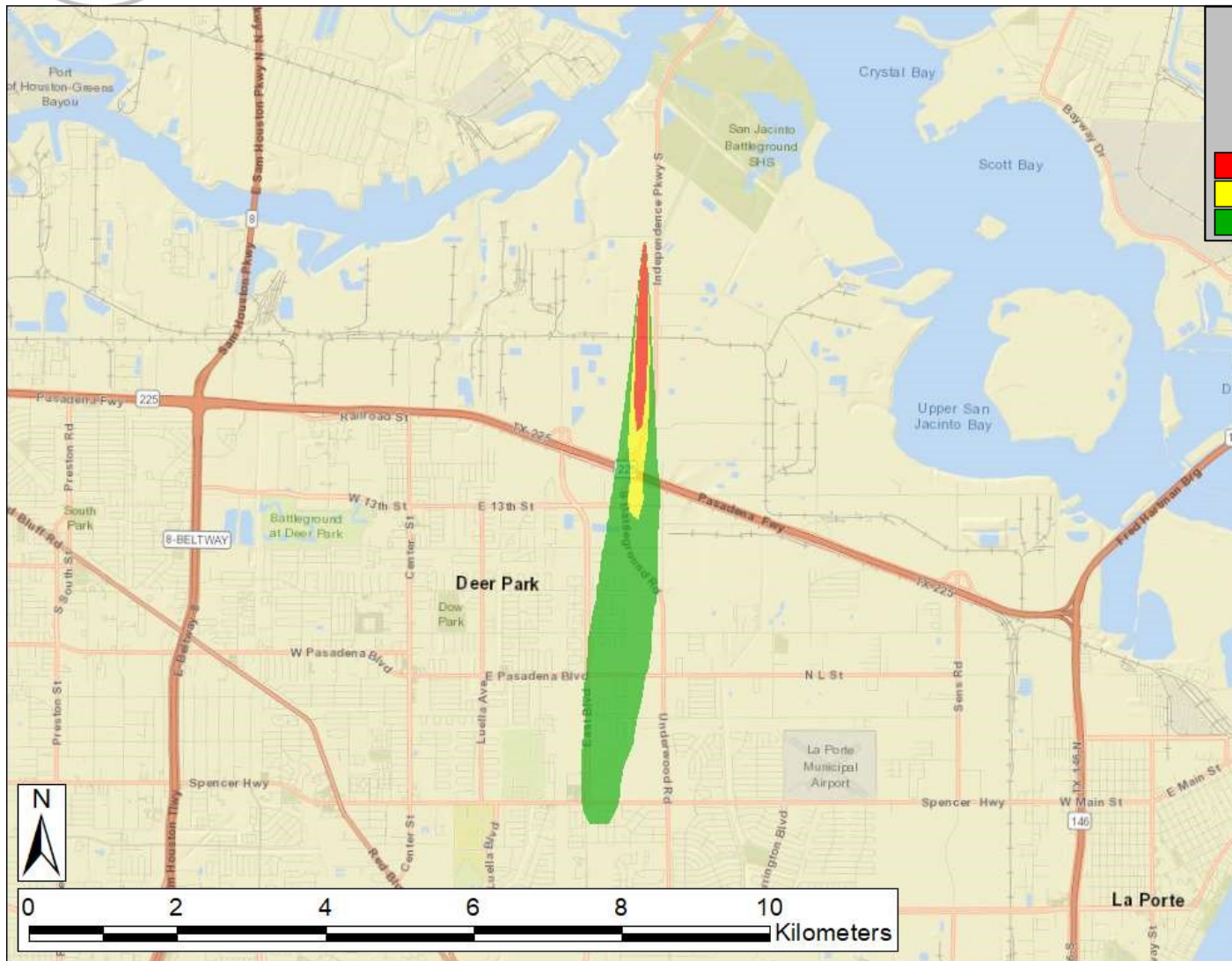
Benzene(Total)
Concentration
26-Mar-19 11:00:00Z (2.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	24
🟨	0.5 ppm	1.595E-06	201
🟩	0.1 ppm	3.19E-07	3,857

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
LandScan 2017

Benzene Conc. @ Ground Level; 0600 CDT 26-MAR (Near View)

Note: Detector readings were taken at an earlier time, but are provided for comparison.

Benzene(Total)
Concentration
26-Mar-19 11:00:00Z (2.000 hr)

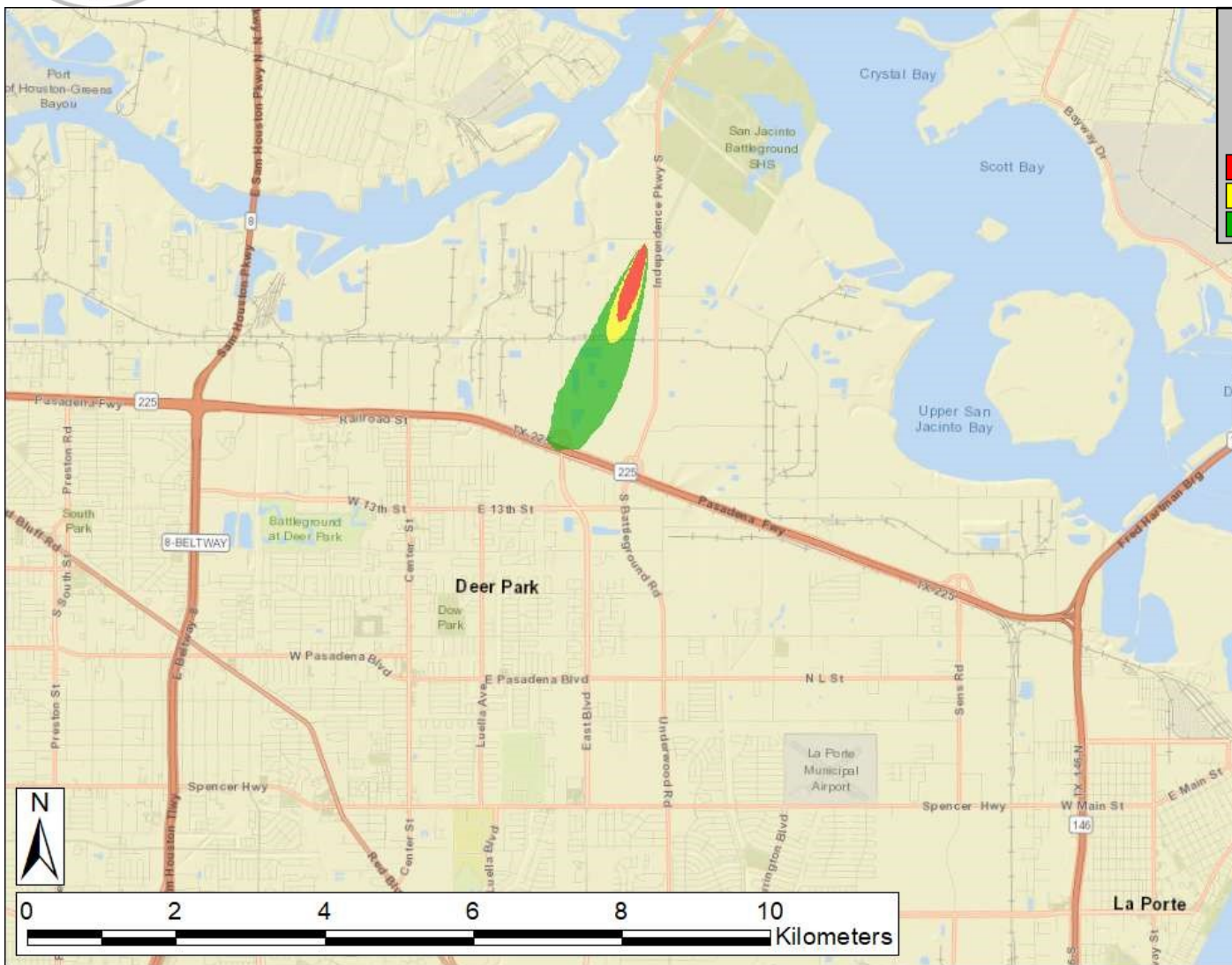|	kg/m3	In contour population
1 ppm	3.19E-06	24
0.5 ppm	1.595E-06	201
0.1 ppm	3.19E-07	3,857

Matching sensor data to model plume calculations is inherently difficult due to the meander and intermittency of real world plume transport and dispersion.

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
  LandScan 2017

N

| 0 | 1 | 2 | 3 | 4 | 5 |
Kilometers

Benzene Conc. @ Ground Level; 0900 CDT 26-MAR (Far View)

Benzene(Total) Concentration
26-Mar-19 14:00:00Z (5.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	17
🟨	0.5 ppm	1.595E-06	22
🟩	0.1 ppm	3.19E-07	52

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
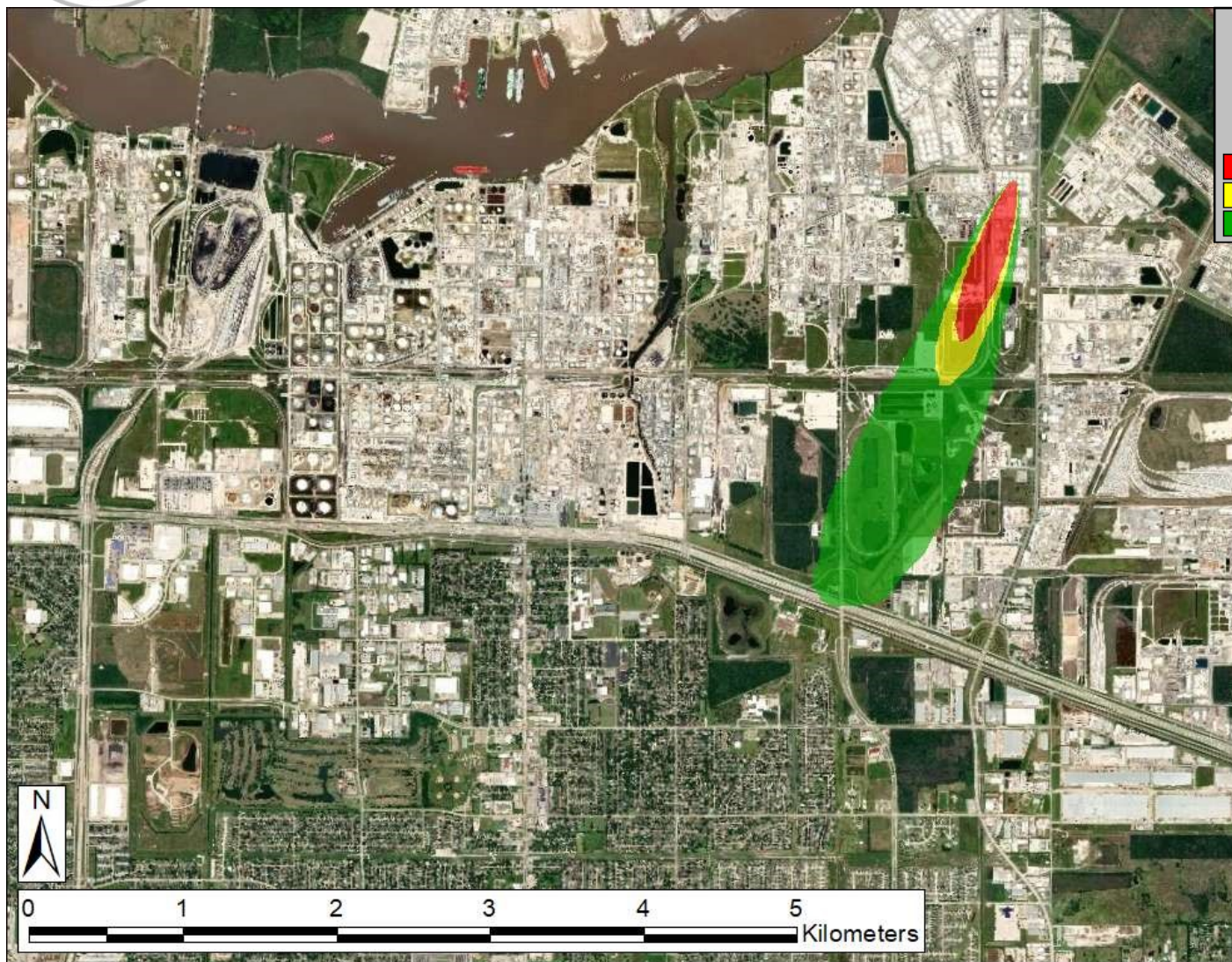Type: Benzene
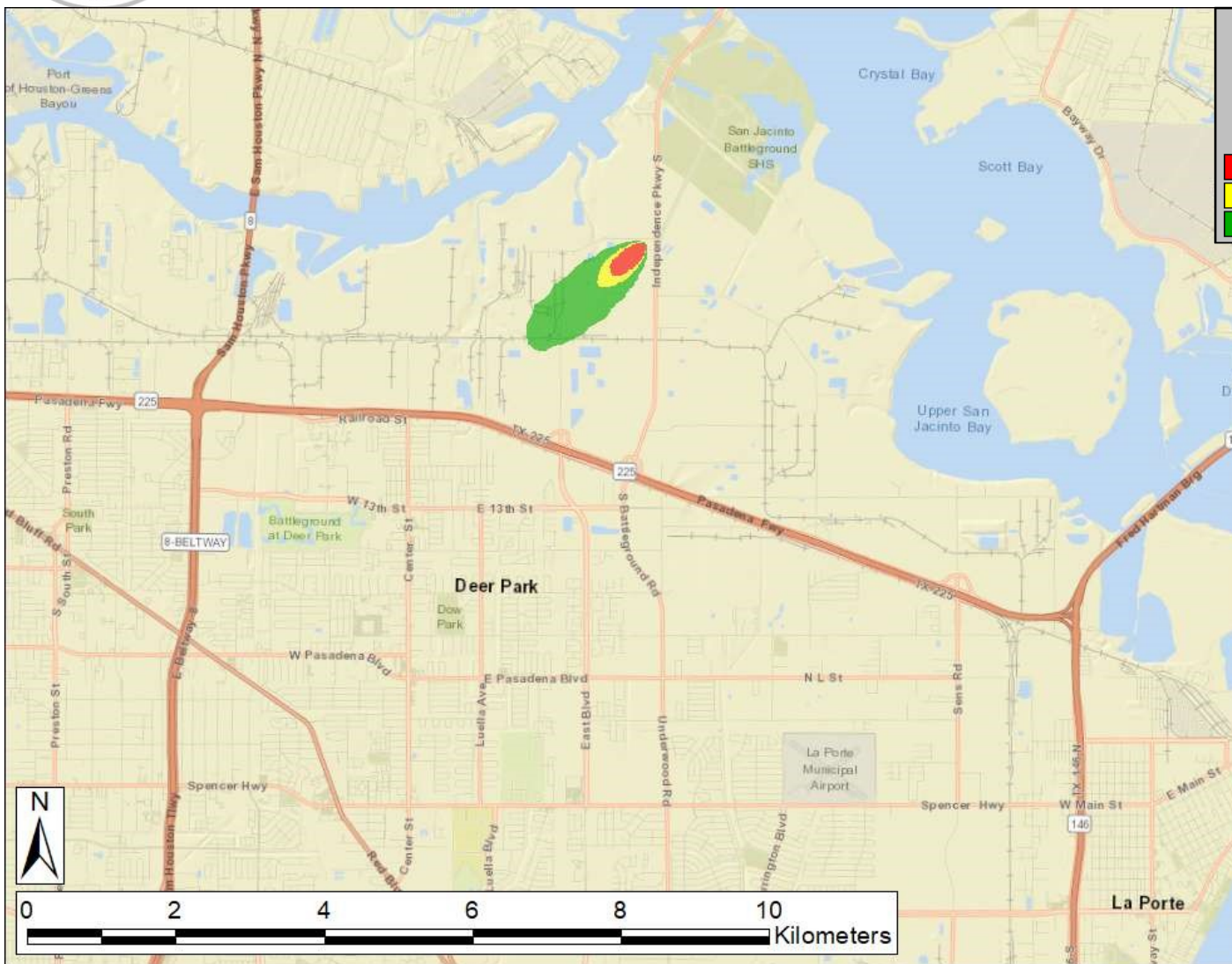Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
   LandScan 2017

Benzene Conc. @ Ground Level; 0900 CDT 26-MAR (Near View)

Benzene(Total)
Concentration
26-Mar-19 14:00:00Z (5.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	17
🟨	0.5 ppm	1.595E-06	22
🟩	0.1 ppm	3.19E-07	52

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
   LandScan 2017

N

| 0 | 1 | 2 | 3 | 4 | 5 |
Kilometers

Benzene Conc. @ Ground Level; 1200 CDT 26-MAR (Far View)

Benzene(Total) Concentration
26-Mar-19 17:00:00Z (8.000 hr)

	kg/m3	In contour population
1 ppm	3.19E-06	14
0.5 ppm	1.595E-06	26
0.1 ppm	3.19E-07	75

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
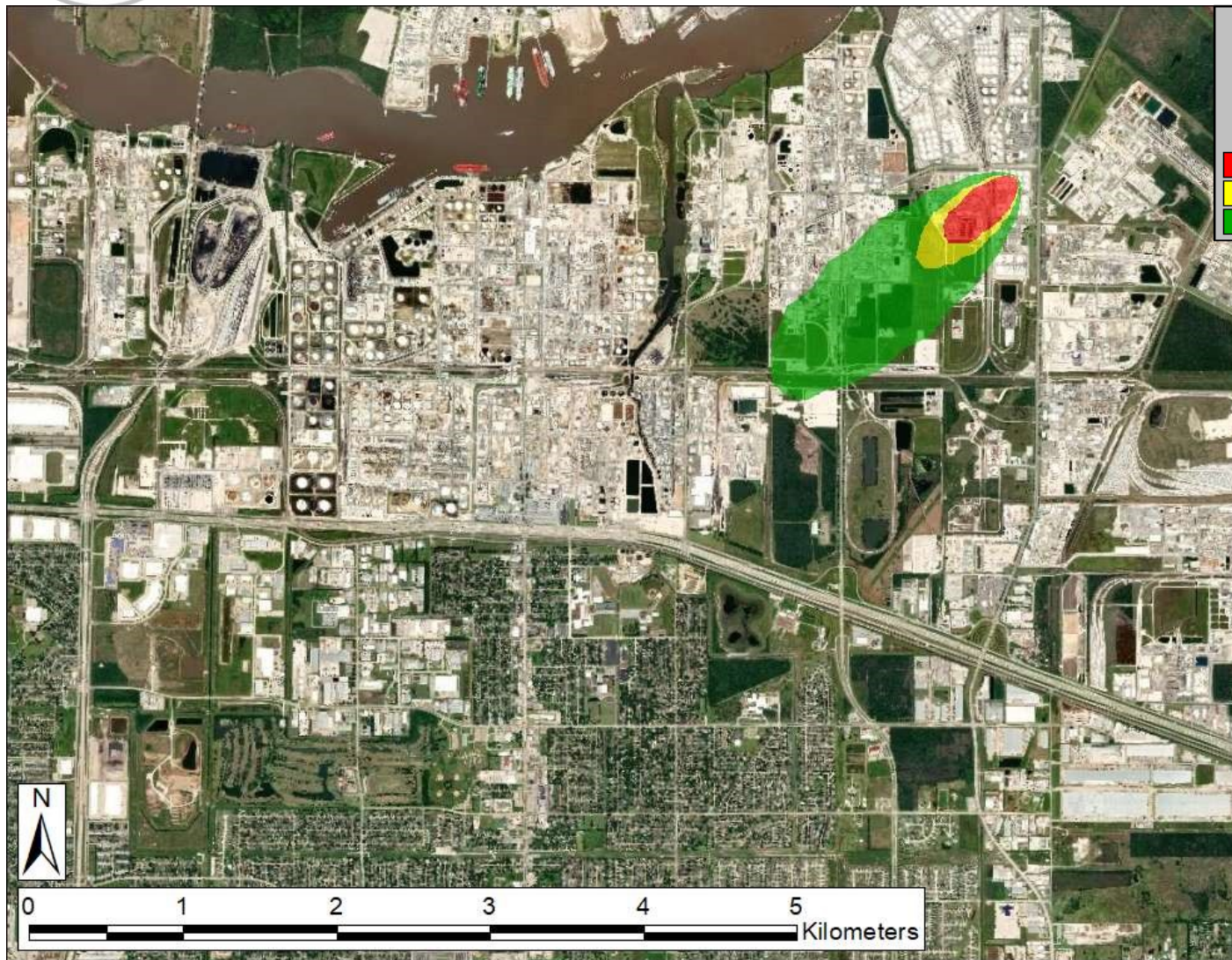Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
   LandScan 2017

Benzene Conc. @ Ground Level; 1200 CDT 26-MAR (Near View)

Benzene(Total)
Concentration
26-Mar-19 17:00:00Z (8.000 hr)

	kg/m3	In contour population
1 ppm (red)	3.19E-06	14
0.5 ppm (yellow)	1.595E-06	26
0.1 ppm (green)	3.19E-07	75

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

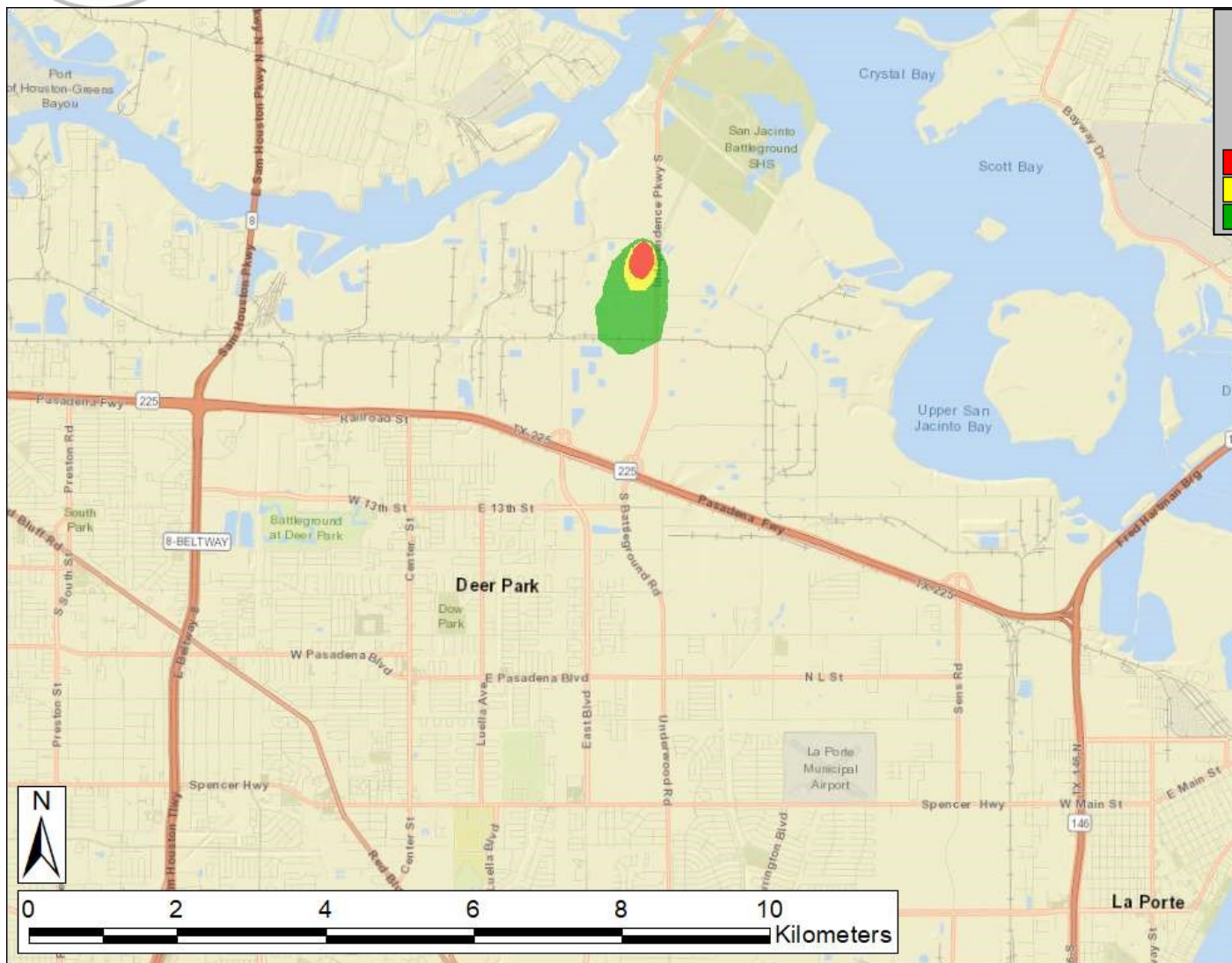Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
LandScan 2017

Benzene Conc. @ Ground Level; 1500 CDT 26-MAR (Far View)

Benzene(Total) Concentration
26-Mar-19 20:00:00Z (11.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	16
🟨	0.5 ppm	1.595E-06	30
🟩	0.1 ppm	3.19E-07	100

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
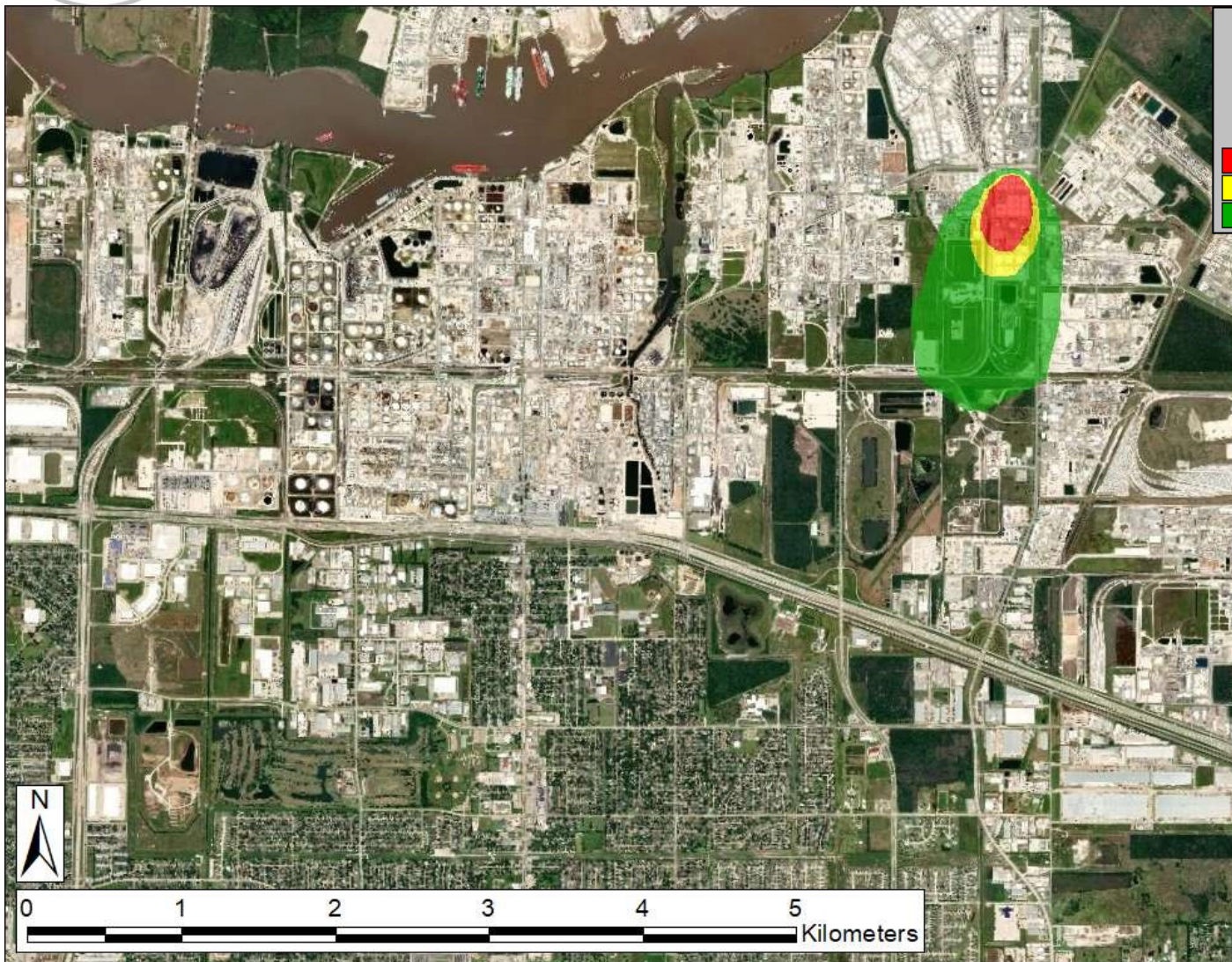Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
    LandScan 2017

Benzene Conc. @ Ground Level; 1500 CDT 26-MAR (Near View)

Benzene(Total)
Concentration
26-Mar-19 20:00:00Z (11.000 hr)

		kg/m3	In contour population
■	1 ppm	3.19E-06	16
■	0.5 ppm	1.595E-06	30
■	0.1 ppm	3.19E-07	100

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
    LandScan 2017

N

0   1   2   3   4   5
Kilometers

Benzene Conc. @ Ground Level; 2100 CDT 26-MAR (Far View)

Benzene(Total) Concentration
27-Mar-19 02:00:00Z (17.000 hr)

	kg/m3	In contour population
1 ppm	3.19E-06	665
0.5 ppm	1.595E-06	3,260
0.1 ppm	3.19E-07	22,095

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5
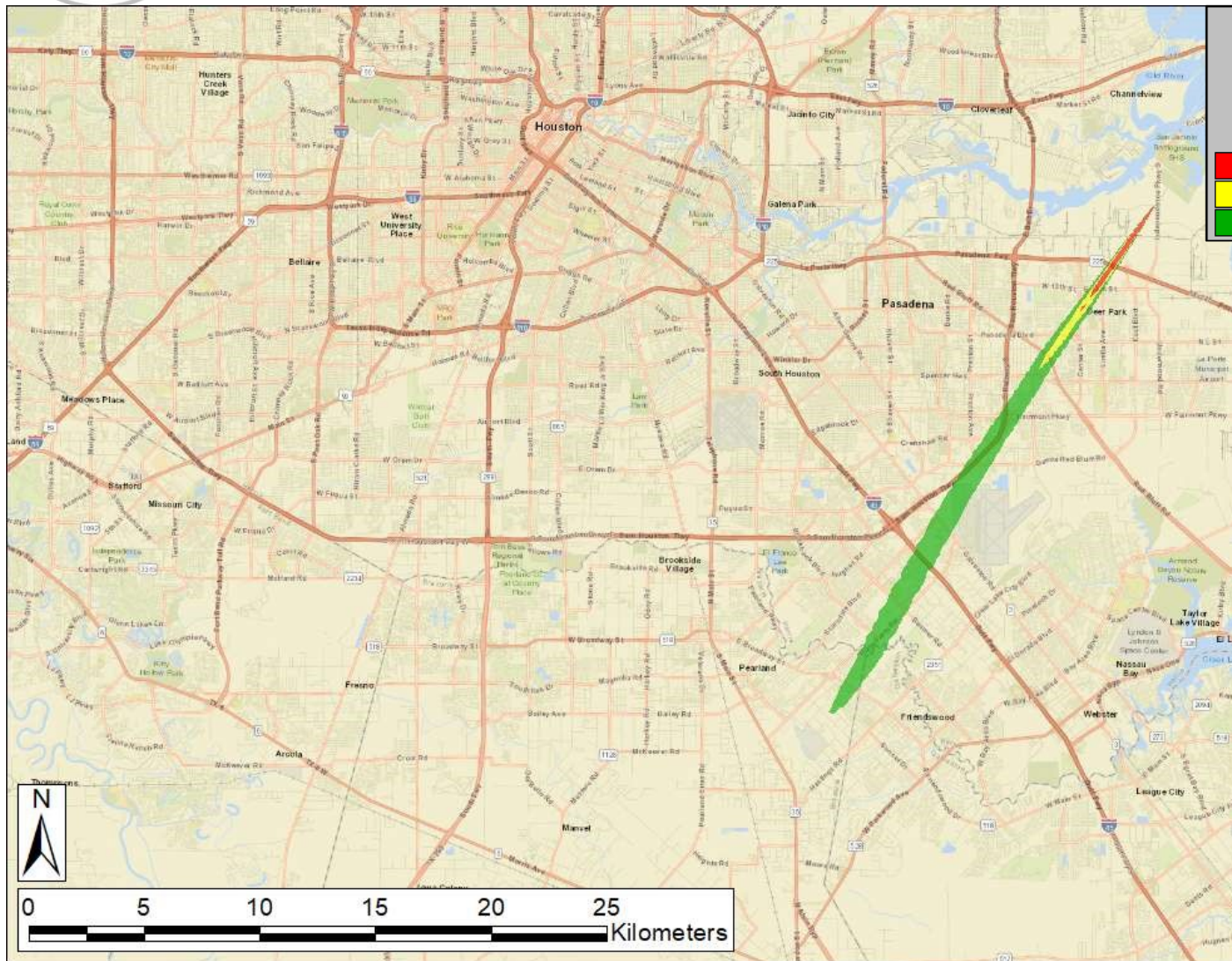
Static Population Estimates:
   LandScan 2017

Benzene Conc. @ Ground Level; 2100 CDT 26-MAR (Near View)

Benzene(Total) Concentration
27-Mar-19 02:00:00Z (17.000 hr)

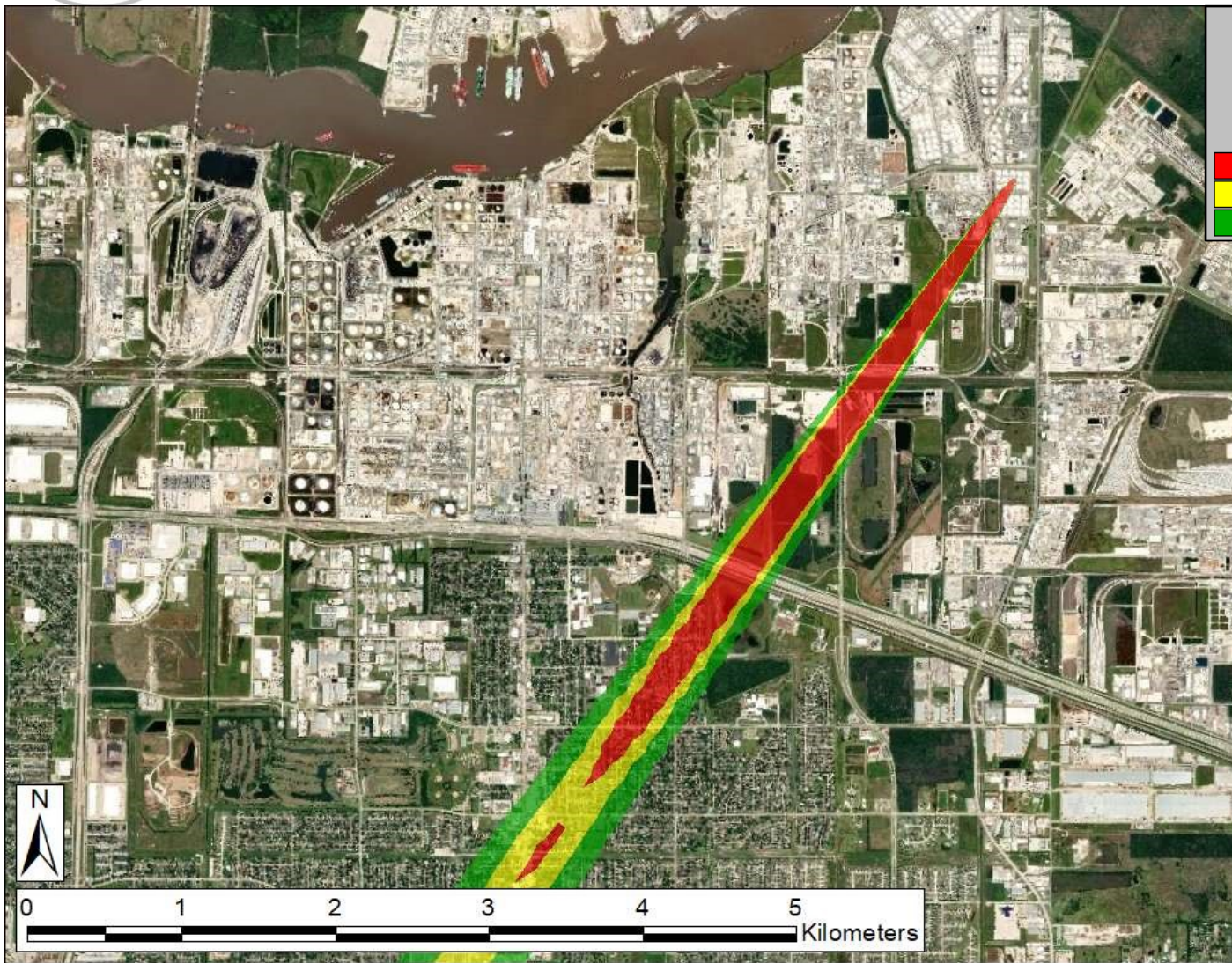|	kg/m3	In contour population
1 ppm	3.19E-06	665
0.5 ppm	1.595E-06	3,260
0.1 ppm	3.19E-07	22,095

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates: LandScan 2017

Benzene Conc. @ Ground Level; 0300 CDT 27-MAR (Far View)

Benzene(Total)
Concentration
27-Mar-19 08:00:00Z (23.000 hr)

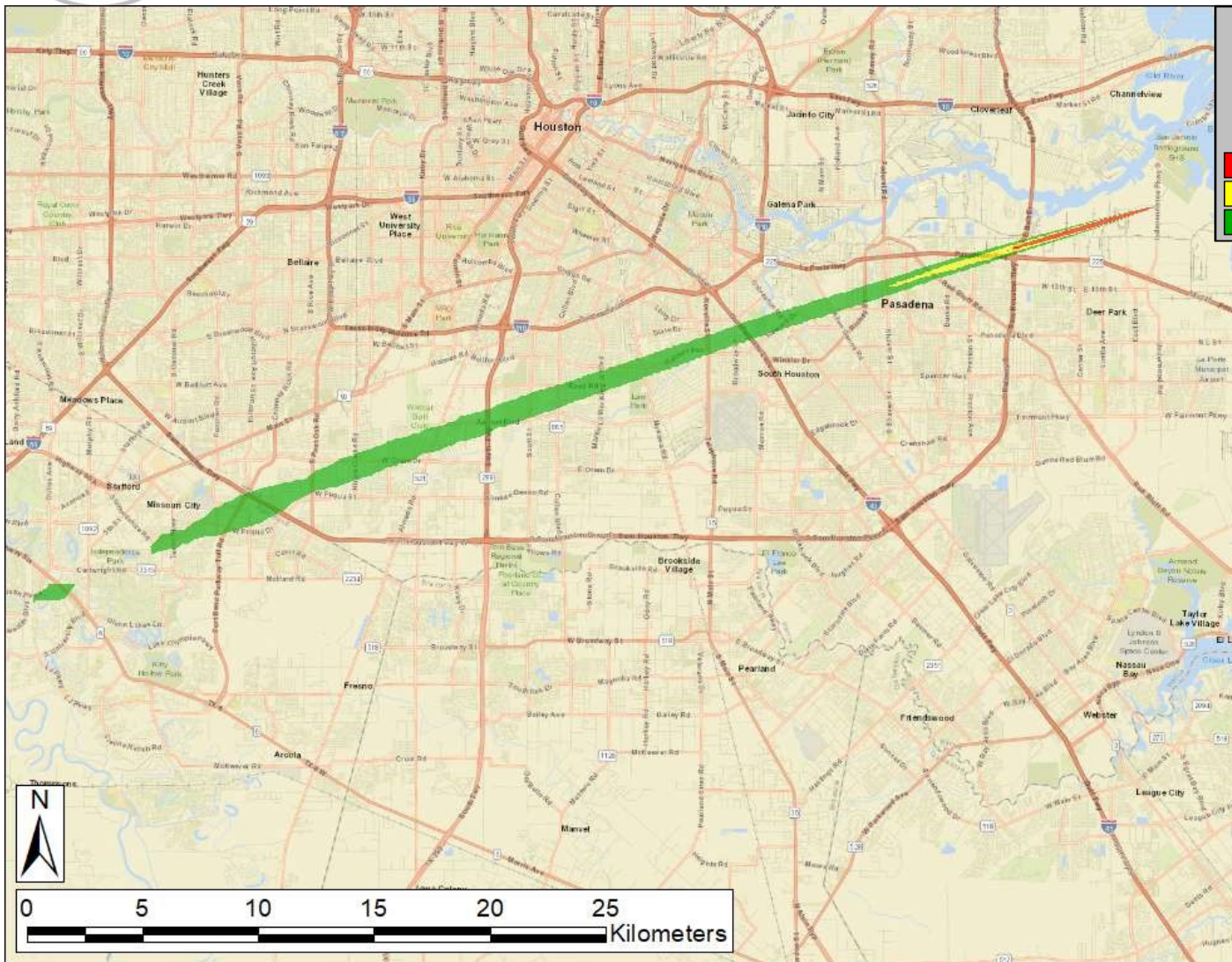|	kg/m3	In contour population
1 ppm	3.19E-06	85
0.5 ppm	1.595E-06	2,392
0.1 ppm	3.19E-07	56,149

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
   LandScan 2017

Benzene Conc. @ Ground Level; 0300 CDT 27-MAR (Near View)

Benzene(Total)
Concentration
27-Mar-19 08:00:00Z (23.000 hr)

		kg/m3	In contour population
▮	1 ppm	3.19E-06	85
▮	0.5 ppm	1.595E-06	2,392
▮	0.1 ppm	3.19E-07	56,149

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
    LandScan 2017

0   1   2   3   4   5
Kilometers

N

Benzene Conc. @ Ground Level; 0900 CDT 27-MAR (Far View)

Benzene(Total) Concentration
27-Mar-19 14:00:00Z (29.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	93
🟨	0.5 ppm	1.595E-06	125
🟩	0.1 ppm	3.19E-07	180

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min
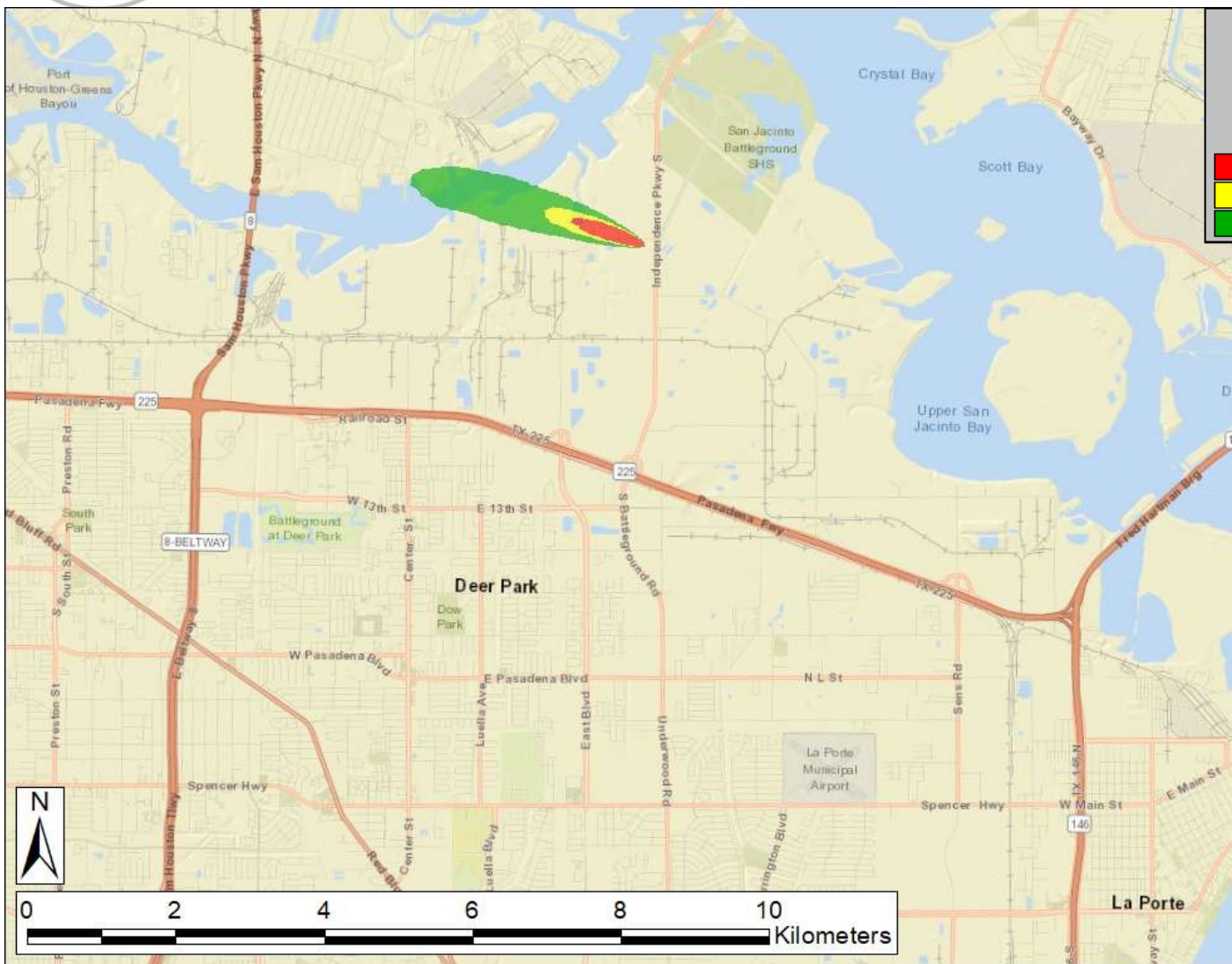
Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
    LandScan 2017

Benzene Conc. @ Ground Level; 0900 CDT 27-MAR (Near View)

Benzene(Total)
Concentration
27-Mar-19 14:00:00Z (29.000 hr)

	kg/m3	In contour population
1 ppm	3.19E-06	93
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0.1 ppm	3.19E-07	180

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

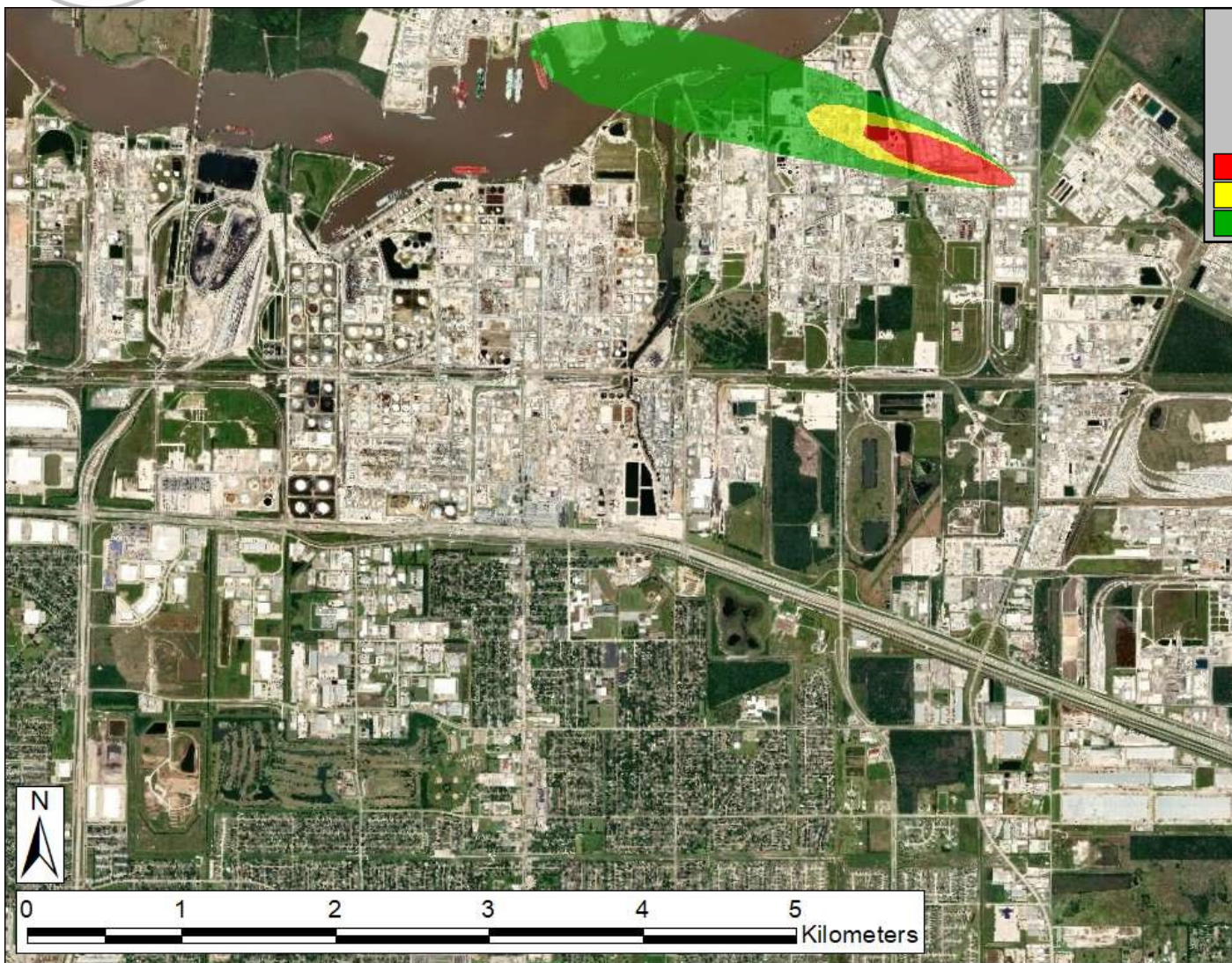Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
  LandScan 2017

Benzene Conc. @ Ground Level; 1500 CDT 27-MAR (Far View)

Benzene(Total)
Concentration
27-Mar-19 20:00:00Z (35.000 hr)

		kg/m3	In contour population
🟥	1 ppm	3.19E-06	54
🟨	0.5 ppm	1.595E-06	118
🟩	0.1 ppm	3.19E-07	369

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
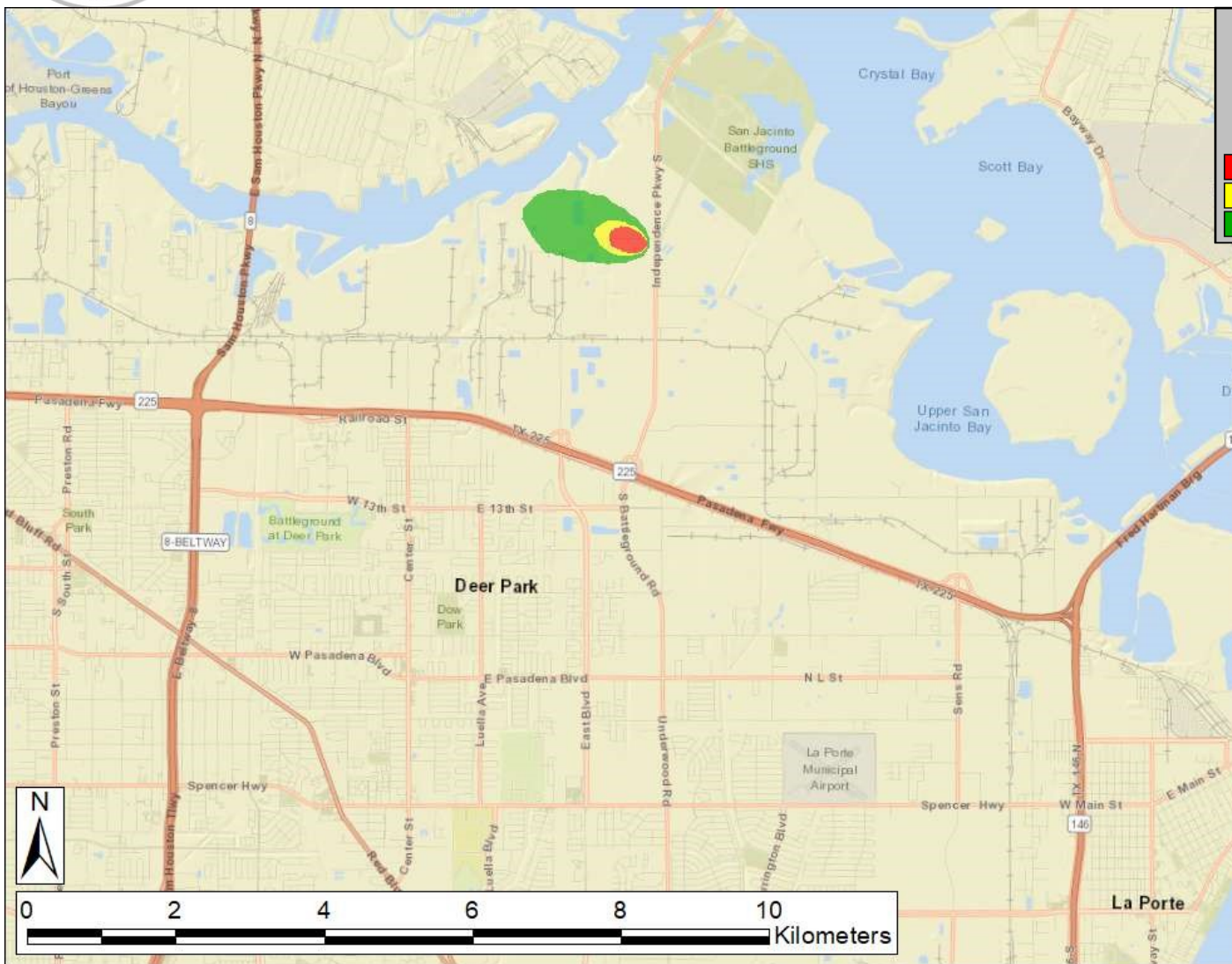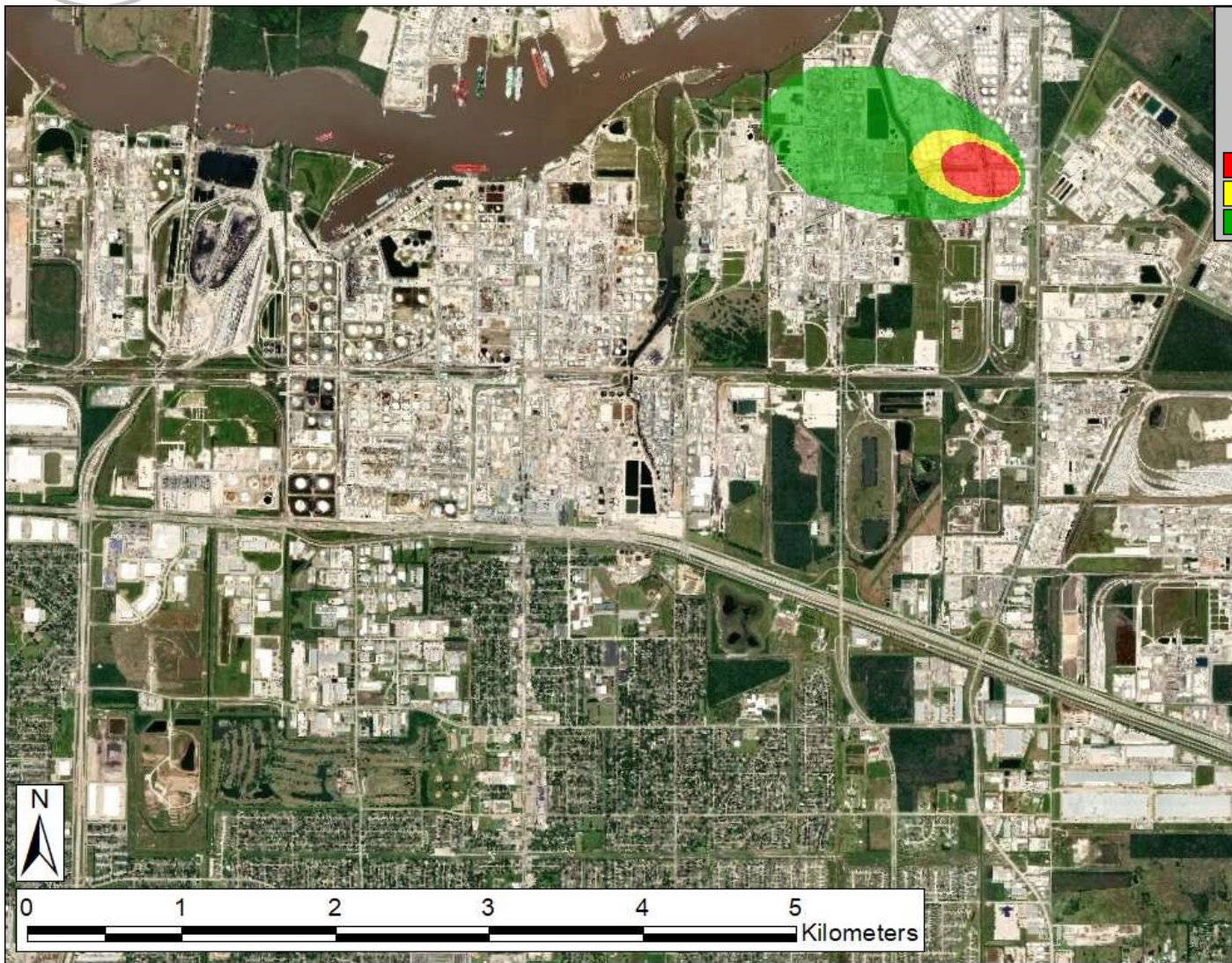Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
    LandScan 2017

Benzene Conc. @ Ground Level; 1500 CDT 27-MAR (Near View)

Benzene(Total)
Concentration
27-Mar-19 20:00:00Z (35.000 hr)

		kg/m3	In contour population
red	1 ppm	3.19E-06	54
yellow	0.5 ppm	1.595E-06	118
green	0.1 ppm	3.19E-07	369

FACTS

Deer Park, TX
Location: 29.732437° N / 95.091517° W
Event Time: 0400 CDT, 26MAR2019
Type: Benzene
Amount: 60 kg/min
Weather: 12 km NAM
Model: HPAC 6.5
Static Population Estimates:
   LandScan 2017

Total Accumulated Dosage; 0400 26-MAR – 1600 27-MAR CDT (Far View)

This plot shows where benzene will be encountered over a 36 hour period, weighted by time and concentration.

Benzene(Total)
Surface Dosage
27-Mar-19 21:00:00Z (36.000 hr)

		kg-s/m3	In contour area (km²)
🟥	100.0	100.0	6.38E-4
🟧	10.0	10.0	1.06E-2
🟨	1.0	1.0	0.127
🟩	0.1	0.1	1.324
🟩	0.01	0.01	18.360
🟦	0.001	0.001	617.703

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

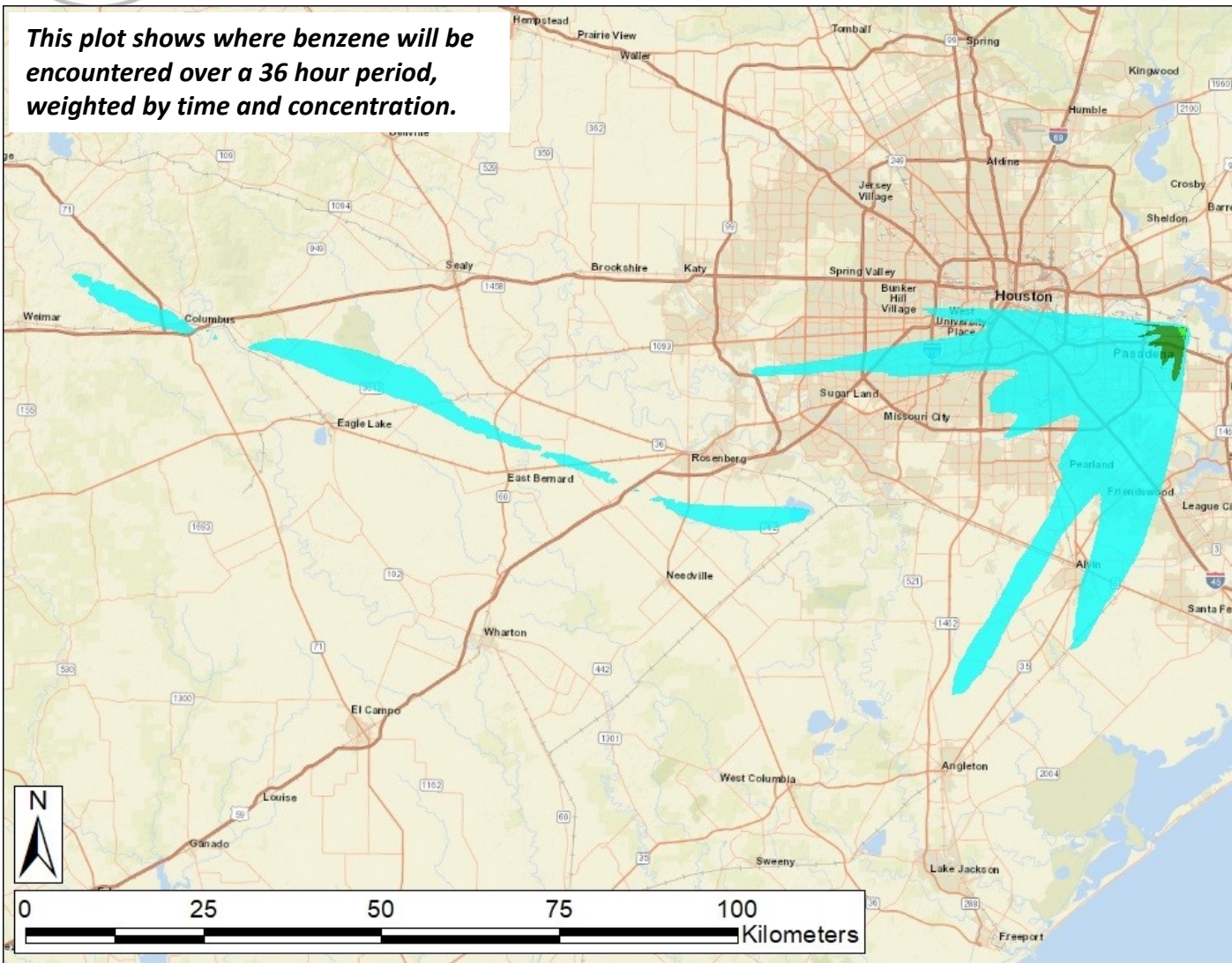Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
  LandScan 2017

Total Accumulated Dosage; 0400 26-MAR – 1600 27-MAR CDT (Near View)

This plot shows where benzene will be encountered over a 36 hour period, weighted by time and concentration.

Benzene(Total)
Surface Dosage
27-Mar-19 21:00:00Z (36.000 hr)

		kg-s/m3	In contour area (km²)
🟥	100.0	100.0	6.38E-4
🟧	10.0	10.0	1.06E-2
🟨	1.0	1.0	0.127
🟩	0.1	0.1	1.324
🟩	0.01	0.01	18.360
🟦	0.001	0.001	617.703

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
   LandScan 2017

N

0   1   2   3   4   5
Kilometers

AEGL Effects; 0400 26-MAR – 1200 CDT 26-MAR

Benzene(AEGLs)
AEGLs
26-Mar-19 17:00:00Z (8.000 hr)

		Value
🟧	AEGL-2 Injury Possible	2.0
🟨	AEGL-1 Threshold	1.0

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

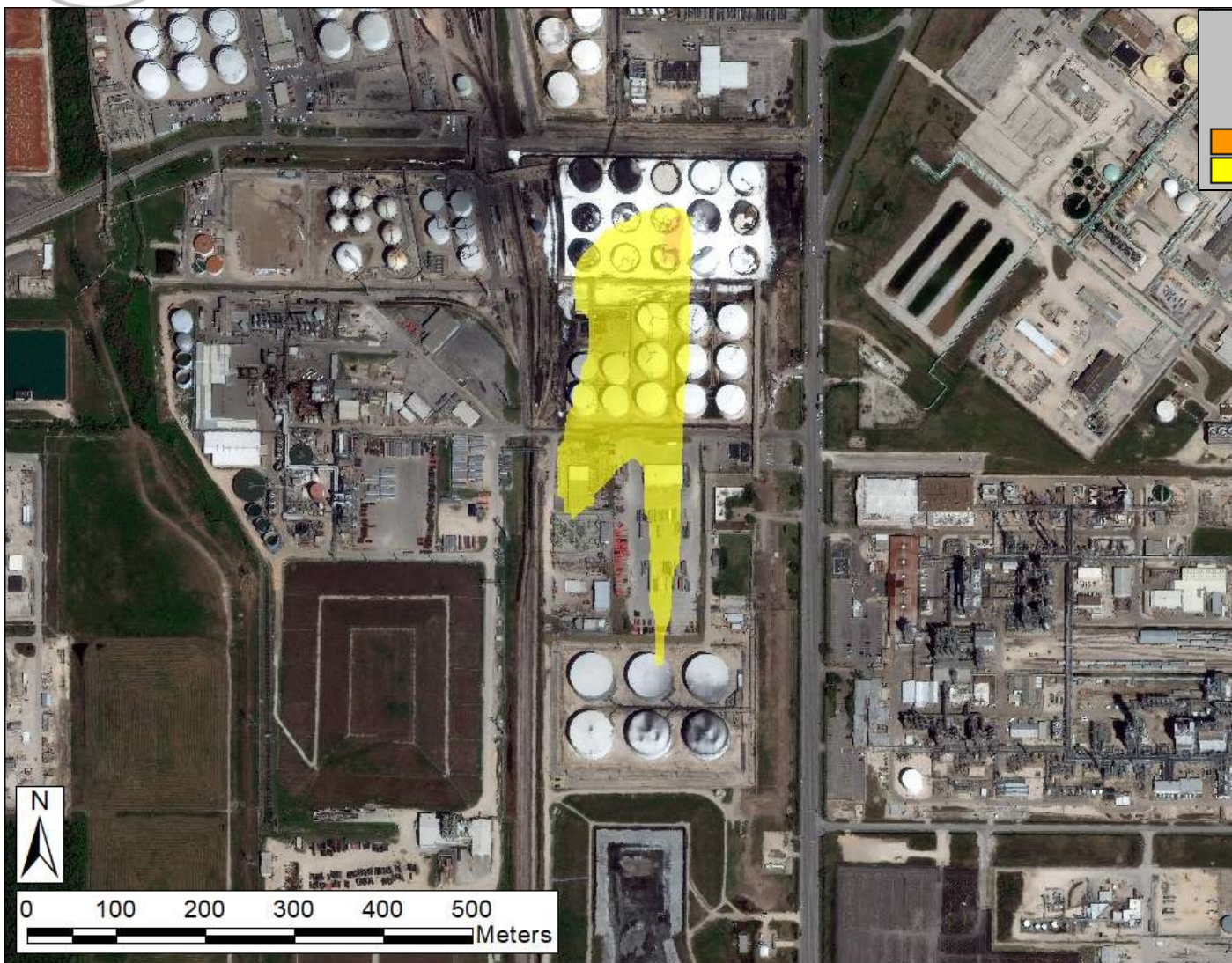Amount: 60 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:
   LandScan 2017

0   100   200   300   400   500
Meters

N

Acute Exposure Guideline Levels (AEGL)

Value	Description
AEGL-3	**Death Possible** - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
AEGL-2	**Injury Possible** - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL-1 **(May not be displayed or defined)**	**Threshold -** the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. It is believed that the recommended exposure levels are applicable to the general population including infants and children, and other individuals who may be susceptible.

FINAL AEGLs – may be used on a permanent basis by all federal, state and local agencies, and private organizations.

INTERIM AEGLs – represents the best efforts of the AEGL Committee to establish exposure limits, and the values are available for use as deemed appropriate on an interim basis by federal and state regulatory agencies and the private sector.

Notes: Casualty numerical figures are based upon a population database (LandScan). LandScan is based on the 2010 census for the U.S. (other nations vary), overhead imagery, geo-economic, and other observable data and was updated in 2017. The population numbers next to associated hazard levels are the people contained within the entire contour based **upon average day and night** time LandScan 2017 data. **Also available are the average day or night** time LandScan 2016 data (US only). For planning purposes, estimates are assumed to be accurate within +10/-5%. Validation testing indicates agreement within 20% for select examined areas. The population data will not predict major shifts in personnel such as relocations (i.e.: religious pilgrimages, refuges, evacuations), events (i.e.: inaugurations, Olympics), or other population shifts. In such cases the population database needs to be updated to reflect actual conditions.